

REMARKS

The Examiner has rejected claims 1-2, 6, 7, 9-19, 26-40, 43, 45-49, 53, 55, 57-64, 67-70, 73, 74, 77-89 and 92-111 are under 35 U.S.C. §103(a) as being unpatentable over combinations of references that include Yao et al. U.S. Patent No. 6,051,114 (hereinafter "Yao") and Yasar et al. U.S. Patent Application Publication No. 2003/0034244 (hereinafter "Yasar").

Applicant has rewritten claims 32, 33, and 94 to be in independent form and canceled all remaining pending claims. These amended claims now more sharply claim simultaneous processes that are used to deposit or repair a layer of ruthenium. Those that are of ordinary skill in the art would readily appreciate that the methods, as claimed herein, would readily apply to barrier and/or seeds layers comprising metals as provided in greater detail in the detailed description. However, ruthenium has been established as particularly useful in the metallization of high aspect ratio features of patterned semiconductor wafers. Consideration is respectfully requested.

The present invention relates to ionized physical vapor deposition (IPVD) performed with a high-density inductively coupled plasma and a process useful for depositing ultra thin layers of ruthenium onto the surfaces of sub-micron, high aspect ratio features on substrates. The process includes the simultaneous depositing of ruthenium and the etching of the deposited ruthenium. This simultaneous process is accomplished by directing ions of the ruthenium onto the substrate for deposition while directing ions of gas onto the substrate for etching.

Yao deals with IPVD using a microwave ECR plasma to totally fill vias and trenches with metal, which is a process that would follow any process for depositing barrier or seed layers. Yao uses the directional IPVD to fill features while etching at the overhangs to prevent closing of the feature before the feature is filled.

The present invention deals with the entirely different problem of applying an ultra thin coating in the features, primarily on their sidewalls. While aspects of the solution are the same as Yao's, the use of those aspects and the others claimed by Applicant to effectively coat feature sidewalls is unobvious. Yao notes in column 2, lines 40-49, of his patent that his invention applies to a fill process performed after a barrier layer is applied by conventional CVD. If it were

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obvious to Yao to use his invention for barrier layer application, he would not have used a very expensive additional module for the barrier layer process. Applicant's methods are not concerned with creating voids due to shadowing by overhangs, but in facilitating the redistribution of material within the high aspect ratio features.

Further, Yao's process is not entirely simultaneous in the sense claimed by Applicant. Specifically, Yao's process includes the pulsing of the DC power source to the substrate while adjusting the target bias. (see generally, Col. 6, Lines 13-27). In reality, this will continually deposit metal onto the substrate at a level determined by the target bias with intermittent etching accomplished by the pulsing of the DC power source to the substrate. This is essentially a sequential process.

Yasar deals with a problem that is more similar to Applicant's than is that of Yao. However, Yasar uses sequential deposition and etching and discusses how the process parameters are to be maintained entirely differently during the deposition steps than during the etching steps. Yasar uses higher deposition rates and higher pressures during its deposition step, and these parameters are incompatible with simultaneously etching.

In view of the foregoing amendments to the claims and remarks given herein, Applicant respectfully believes this case is in condition for allowance and respectfully requests allowance of the pending claims. If the Examiner believes any detailed language of the claims requires further discussion, the Examiner is respectfully asked to telephone the undersigned attorney so that the matter may be promptly resolved. The Examiner's prompt attention to this matter is appreciated.

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Applicant is further of the opinion that an additional fee is due for a fifth month extension and for the filing of this RCE. Payment of all charges due for this filing is made on the attached Electronic Fee Sheet. If any additional charges or credits are necessary to complete this communication, please apply them to Deposit Account No. 23-3000.

Respectfully submitted,

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